

## Polarization analysis of Pc 1 geomagnetic pulsations observed at multi-point ground stations at middle latitudes

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Pc 1 geomagnetic pulsations, which are geomagnetic field fluctuations with frequencies of 0.2-5 Hz, propagate from the high-latitude source region to middle latitudes in the ionosphere. The high-latitude source region links to the inner magnetosphere where ion cyclotron instability occurs associated with large density gradient near the plasmapause. The polarization analysis of Pc 1 pulsations observed at middle latitudes enables us to understand the spatial structure and temporal variations of the high-latitude source region. In this study, we investigate spectral and polarization characteristics of Pc 1 geomagnetic pulsations observed at Paratunka (PTK, 53.0N, 158.2E, magnetic latitude (MLAT): 45.8N), Moshiri (MSR, 44.4N, 142.3E, MLAT: 35.7N), and Sata (STA, 31.0N, 130.7E, MLAT: 22.0N) using induction magnetometers with a sampling rate of 64 Hz. From the polarization analysis of the Pc 1 pulsations observed on November 5, 2007, we found that the polarization direction varies  $\sim 40$  degrees depending on frequencies of 0.4-0.7 Hz. We call such Pc 1 characteristics as 'Gradation Pc 1'. This Pc 1 feature suggests either the spatial structure of the high-latitude Pc 1 source region or the effects of duct propagation in the inhomogeneous ionosphere.

In order to understand the characteristics of the gradation Pc 1, we made statistical analyses of 64 Pc 1 events observed at MSR during July 2007-August 2008. We found that these Pc 1 events tend to occur in November-April and for most of the local times except at around 1500LT. From superposed epoch analyses for Dst and AE indices, we found that the Pc 1 events were observed  $\sim 2-4$  days after geomagnetic disturbances. Fifteen events of gradation Pc 1 were identified from these 64 Pc 1 events. These statistical characteristics are mostly same for the gradation and non-gradation Pc 1 events. The only difference is that the gradation Pc 1 events occur only in the dawn sector. Based on these results we discuss possible Pc 1 source distributions in the high-latitude ionosphere that cause the observed feature of the gradation Pc 1 pulsations. For a gradation Pc 1 event of November 5, 2007, we estimated the longitudinal extent of the high-latitude Pc 1 source region to be  $\sim 800$  km from the polarization angle variations. We also suggest that the Pc 1 pearl structures observed at middle latitudes are beating waves produced by the mixture of Pc 1 waves with slightly different frequencies from the high-latitude ionosphere.